DRAFT

TRAFFIC CALMING MANUAL

BURLINGTON, VERMONT

SEPTEMBER 2020

Stantec

ACKNOWLEDGEMENTS

Thanks to the following of their involvement in reformatting this manual, adding the necessary elements to clarify the City's programs for Traffic Calming and Neighborhood Enhancement.

Burlington City Staff

Nicole Losch
Elizabeth Gohringer
Laura Wheelock
Susan Molzon
Chapin Spencer
Norm Baldwin

Stantec Consultant Team

Greg Goyette
Mike Rutkowski
Timothy Tresohlavy
Erica Ortman
Jaquasha Colon
Dan Hemme
Dylan McKnight

"We want to create safer streets for everyone, and make walking and biking a viabe and enjoyable way to get around town." - PlanBTV

Burlington Public Works Department
645 Pine St Suite A
Burlington, VT 05401
(802) 863-9094

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TRAFFIC CALMING HISTORY IN BURLINGTON

We work for you, residents and visitors of Burlington.

We are your Department of Public Works (DPW) and we provide drinking water, collect and treat wastewater, construct and maintain sidewalks, roads, and other infrastructure. We manage traffic and parking systems, maintain compliance with fire and life safety codes, pick up your recycling, and many more services. Traffic calming is merely one element of our commitment to you.

Transportation

Our Technical Services Division provides engineering and planning services relating to transportation, traffic signals, and long-range multimodal planning. We care about sidewalks, bicycle lanes, streetscape improvements, and quality of life just as much as you. We plan for the long-term, such as our PlanBTV Walk-Bike Master Plan, as well as our short-term, including our many demonstration projects to temporarily re-imagine public spaces.

This traffic calming manual builds upon and replaces prior guiding manuals, including the Neighborhood Traffic Management guide (2005), as well as the Traffic Calming section of the Burlington Transportation Plan - Street Design Guidelines. Moving forward, this manual will serve as the prevailing resource for Traffic Calming requests.

Commitment to Complete Streets

Our City is committed to providing connected, safe, affordable, efficient, and convenient transportation choices. These are our foundational principles for making every Burlington street "complete."

We believe that our streets are public spaces, and serve more functions than simply moving cars. This is why we've maintained a Neighborhood Enhancement Program since 1996, to establish policies and process to balance mobility needs.

Figure 1. Recent transportation planning documents for the City of Burlington (Source: City of Burlington, VT)

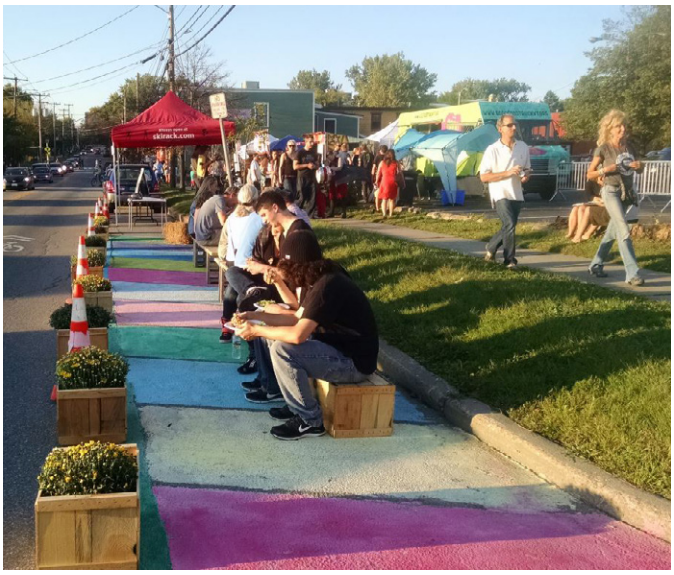


Figure 2. Tactical urbanism project in Burlington, VT (Source: Tactical Urbanist's Guide to Materials and Design)

01 INTRODUCTION

This Traffic Calming Manual represents an important step for the City of Burlington in its mission to provide safe, Complete Streets within the community. Building upon previous efforts to identify traffic calming measures suitable for construction, this manual provides the City of Burlington with:

1. Guidance regarding the appropriate use, design, and signing and/or pavement markings of traffic calming measures;
2. Procedures by which residents may request and the City may investigate and pursue traffic calming measures on its residential and collector streets.

This Guide focuses on traffic calming measures for existing streets. The goals of this program are:

- **Protect** existing residential neighborhoods through traffic and speed management
- **Promote** safe, comfortable, multimodal transportation
- **Provide** acceptable leves of access, while minimizing unnecessary traffic or excessive speeds.

WHAT IS TRAFFIC CALMING? WHY IS IT IMPORTANT?

The Federal Highways Administration (FHWA) describes traffic calming as follows:

> *The primary purpose of traffic calming is to support the **livability** and **vitality** of residential and commercial areas through improvements in non-motorist safety, mobility, and comfort. These objectives are typically achieved by **reducing vehicle speeds** or **volumes** on a single street or a street network. Traffic calming measures consist of horizontal, vertical, lane narrowing, roadside, and other features that use **self-enforcing** physical or psycho-perception means to produce desired effects.*[1]

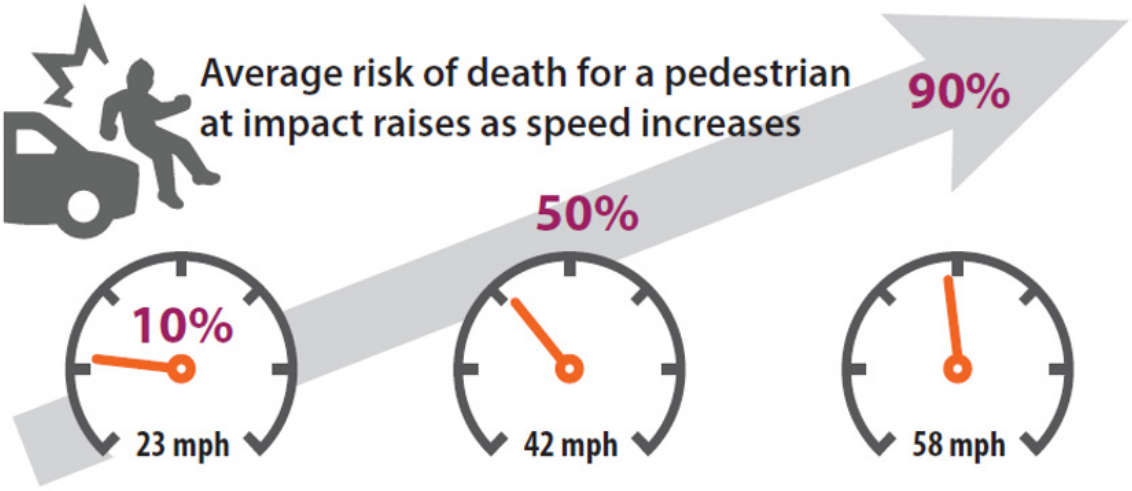


Figure 3. Pedestrian fatalities dramatically increase as vehicle speed increases

[1] *Traffic Calming ePrimer, Module 2. Federal Highways Administration (FHWA), Office of Safety. https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module2.cfm#mod21 Accessed March 2020.*

The essential elements of traffic calming remain the same: (1) reduction of automobile speeds and/or volume, (2) through the use of physical measures, (3) to improve quality of life in residential and commercial areas, and (4) increase the safety of pedestrians and bicyclists.

Traffic calming is important because it increases the quality of living in urban and suburban settings by making movement safer and more efficient for all street users. Reducing vehicle speed is especially critical for pedestrians and vulnerable users of all streets, as the risk of death at impact increases with speed.

Figure 4. Traffic calming can help make Burlington's streets safer.

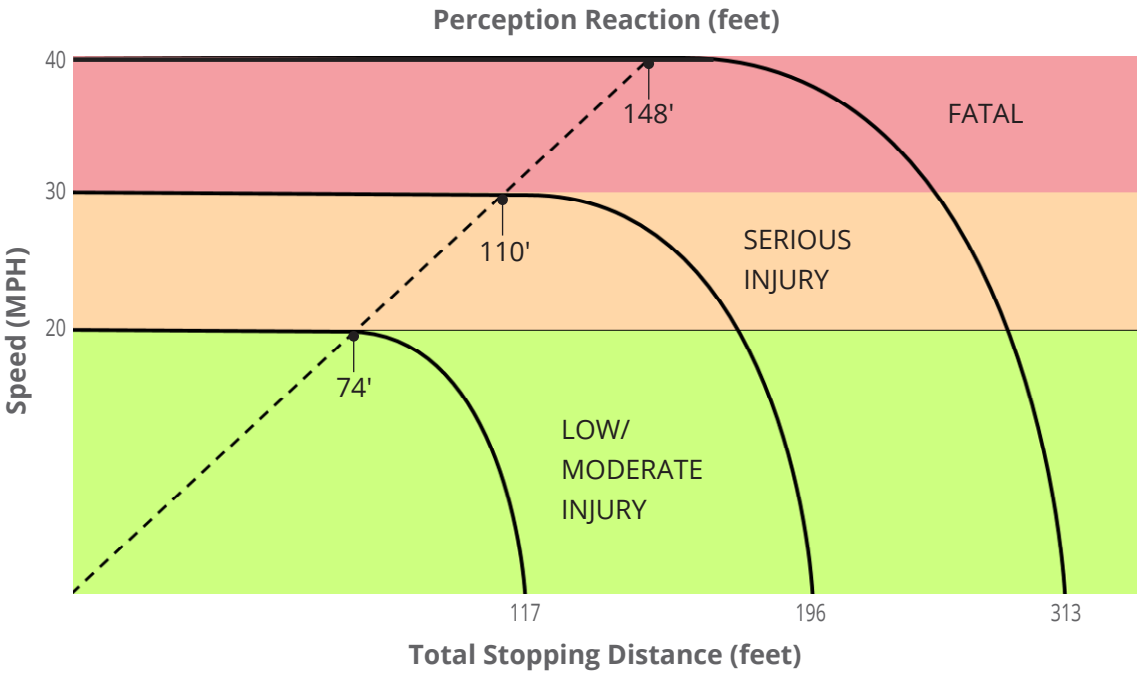


Figure 5. Stopping distance and reaction time increase with speed. (Source: National Complete Streets Coalition)

Peripheral Vision at 10 to 15 MPH

Peripheral Vision at 40+ MPH

Figure 6. Diagrams (above and below) illustrating how driver vision narrows and widens at high and low speeds respectively. Studies show that driver behavior, including speed, is predicated on their peripheral vision, which decreases greatly at higher speeds.

WHAT IS *NOT* TRAFFIC CALMING?

It's important to clarify potential treatments that will not be considered as traffic calming measures. Four common requests from residents include: **stop sign installation requests, speed radar equipment installation, driver safety education, or speed limit enforcement efforts** by local police. While stop signs and other traffic control signs are means by which traffic operations may be managed, they are not traffic calming devices because they are not **self-enforcing**. As regulatory traffic control devices, traffic control signs obligate the motorist to alter their driving behavior and reduce speed, but *require enforcement* by authorities in order to be effective rather than the operator's voluntary modification of their behavior. Vehicle safety education is an essential requirement for obtaining a state drivers' license, but is not in itself a traffic calming measure because it is not a physical treatment that is self-enforcing. For these reasons, requests of this nature will not be considered under the City's Traffic Calming Program.

What is "Self-Enforcing?"

Physical treatments (countermeasures) that are engineered to alter a motorists speed or direction of travel.

HOW IS TRAFFIC CALMING DIFFERENT FROM NEIGHBORHOOD ENHANCEMENT?

- **Traffic Calming:** Physical, self-enforcing measures that will mitigate an issue that exceeds specific quantitative warrants for speed, crashes, and heavy traffic/truck traffic are considered traffic calming. Traffic calming measures will be evaluated in accordance with Chapter 2 of this manual.
- **Neigborhood Enhancements:** Issues or desired improvements at locations which do not meet the specific quantitative warrants for speed or crashes (e.g., maintenance, street trees, sidewalks, lighting, education, enforcement). The following are examples of neighborhood-led requests through other established programs within the City of Burlington:
  - "Welcome to the Neighborhood" signs, planters, or other beautification (apply for Encumbance Permit through DPW)
  - New tree requests through Burlington, Parks, Recreation and Waterfront
  - Street light improvements through Burlington Electric Department
  - Intersection murals (apply for an Encumbrance Permit through DPW)

The Traffic Calming Program addresses specific *roadway deficiencies as demonstrated by data* through proven countermeasures, and are guided by accepted engineering standards established by research administered and endorsed by Federal and State agencies.

↑ Figure 7. DPW employees installing traffic calming measures

↑ Figure 8. An artistic neighborhood enhancement installation in Burlington that serves to beautify the area and may calm traffic

A NOTE ON INTERSECTION MURALS

Intersection murals have the potential to compromise safety of motorists, pedestrians, and bicyclists by interfering with, detracting from, or obscuring official traffic control devices, especially nearby crosswalks. Intersection murals will only be considered after careful review of their location, impact to nearby official traffic control devices, and the safety of the public. For more information, refer to the Manual on Uniform Traffic Control Devices, Frequently Asked Questions - Part 3 - Markings.

02 TRAFFIC CALMING EVALUATION PROCESS

This manual is intended to assist DPW and the citizens of Burlington. It will be used by Department of Public Works (DPW) staff to evaluate whether requests for traffic calming will follow the Traffic Calming Program. The objective is to provide clear, transparent guidance to the public, and simplify the overall process from initiation to implementation.

The traffic calming program is designed for streets with posted speeds less than or equal to 30 mph, and is not necessarily appropriate for multilane corridors.

The goals of this program are:

- *Protect existing residential neighborhoods through traffic and speed management*
- *Promote safe, comfortable, multimodal transportation*
- *Provide acceptable leves of access, while minimizing unnecessary traffic or excessive speeds*

HOW TO USE THIS MANUAL

Refer to the Traffic Calming Evaluation Flowchart on the following page.

Upon receipt of a formal **Report of Problem** (public request via SeeClickFix or contacting DPW directly), the first decisionpoint is whether the problem relates to: speed, crashes, traffic volume, or heavy truck traffic.

The next step is a formal **Traffic Calming Assessment** by conducting a field review, collecting traffic data, or analyzing existing data. The type of traffic data collected will be dictated by the nature of the problem (speed, traffic, crash records). **Speed** data may involve the collection and analysis of vehicles over a 48-hour period to determine the 85th percentile differential measurement, operating under typical traffic conditions while schools are in session. **Crash** data may involve research on the current VTrans annual Crash Rates calculations, as well as crash records from VTrans Annual State Crash Database, or Crash Public Query Tool. **Volume/Heavy Truck** data may involve conducting a 24- or 48-hour vehicle classification count, specifically for vehicles with three or more axles. The Department of Public Works will collect and analyze these data to determine if specific threshold criteria warrants are exceeded.

Basics of Traffic Calming Process:

- *Requests are initiated by contacting DPW or using SeeClickFix*
- *If warrants are met (See Criteria Warrants, p.7), DPW will develop traffic calming concepts that address the problems identified by the data*
- *A neighborhood meeting will be scheduled to provide feedback on concepts. If needed, a second meeting will be scheduled to share updated plans. DPW will follow the Public Engagement Plan for neighborhood outreach.*
- *If warrants are not met, the traffic calming request will be closed and new requests for that location will not be considered for 5 years unless traffic or development has substantially changed. Neighborhood enhancements can be considered.*
- *DPW will post the results of warrant analysis onto www.burlingtonvt.gov/dpw*

TRAFFIC CALMING EVALUATION FLOWCHART

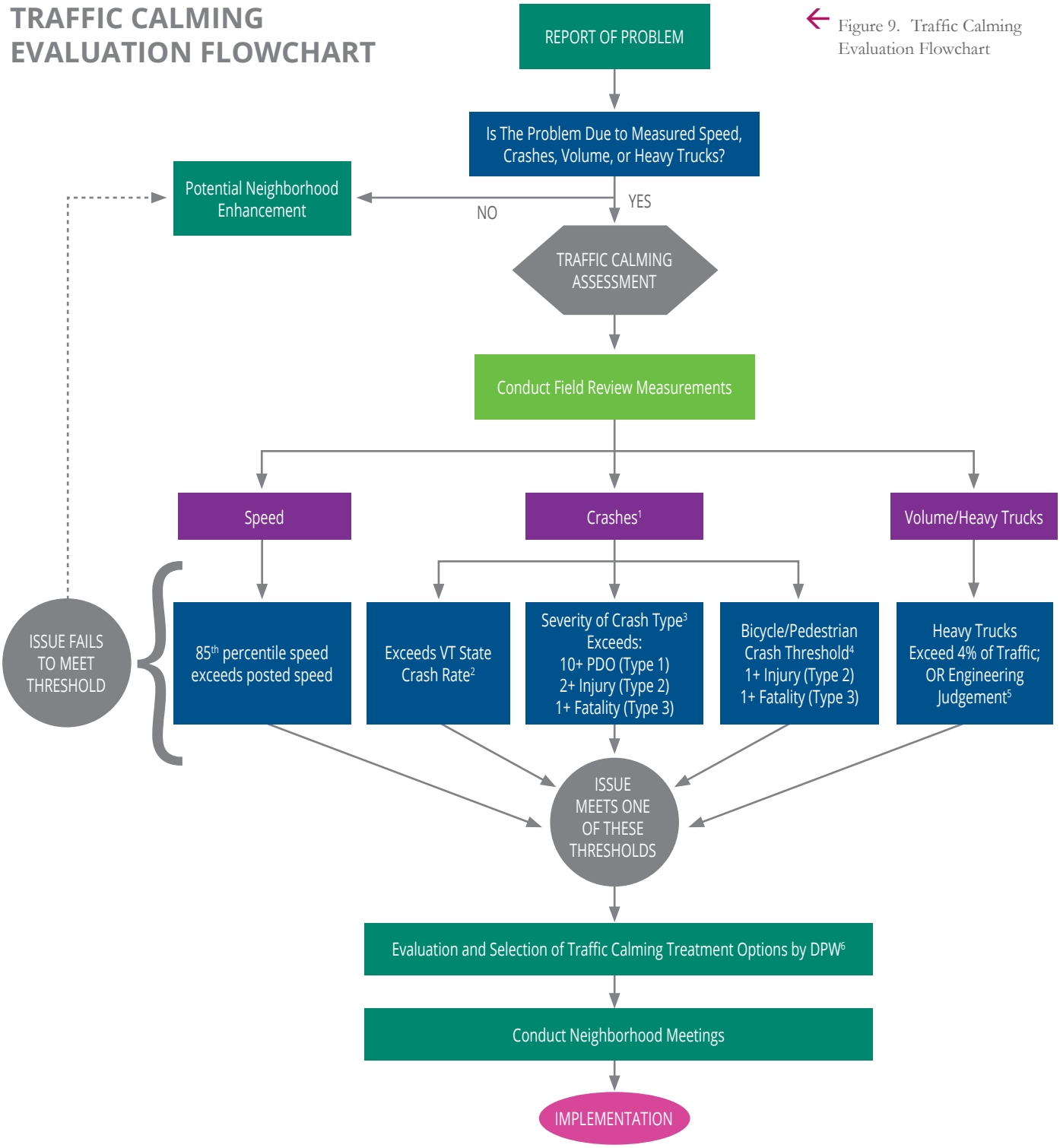


Figure 9. Traffic Calming Evaluation Flowchart

Assumptions:

[1] The City of Burlington may adopt a Vision Zero policy. When the policy is adopted, severity of crash thresholds will be re-evaluated to align with the policy.

[2]Use Annual Crash Rate; Source: https://vtrans.vermont.gov/docs/highway-research

[3]Use Annual State Crash Database; Source: https://vtrans.vermont.gov/crash-manual

Property Damage Only (Type 1) – No injuries or deaths involved

Injury (Type 2) – A person(s) is injured, but no one is killed

Fatality (Type 3) – If any person is killed in the crash

[4]Bike/Ped crashes based on one year occurrence; Source: http://apps.vtrans.vermont.gov/CrashPublicQueryTool/

[5]Truck volume percentage based on 24-hr volume classification count, Heavy Trucks represent 3+ axles

[6]See page 11 for Treatment Options

[7]Engineering judgment applies to assumptions 2-6 above.

Figure 10. Crashes in Burlington, VT from March 15, 2019 to April 14, 2020 (Source: VTrans Public Crash Data Query Tool)

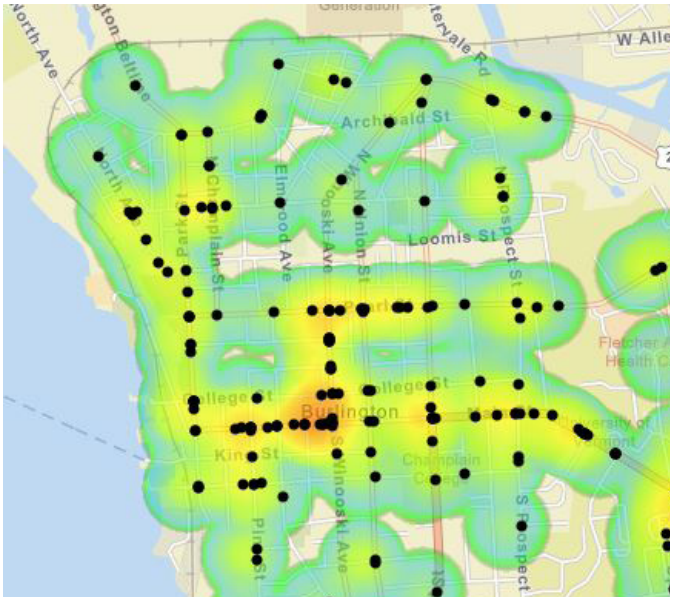


Figure 11. Pedestrian priority and safety is paramount, especially on neighborhood streets.

THRESHOLD CRITERIA WARRANTS

With the appropriate data collected, the next decision point is whether the reported problem meets or exceeds the established Criteria Warrants, which are minimum criteria for correction of a deficiency. These are listed in the column to the right.

An assessment that satisfies these warrants proceeds to the next decision point, consideration of methods and treatment options, presented in the next section. Cost-effective treatments will largely depend on the characteristics of the roadway, as not all traffic calming treatments will be effective on different streets. Further discussion of street typologies follows.

An assessment that *does not* satisfy these warrants will not advance for traffic calming treatments. New requests for traffic calming will not be advanced for 5 years unless there is a substantial change in traffic or development nearby. DPW will provide results of all assessments at www.burlingtonvt.gov/dpw.

Criteria Warrants

- **Speed Warrant:** The reported 85th percentile speed differential measurement is greater than the posted speed.
- **Safety Warrant:** Documented crash history along the roadway:
  - » Exceeds the annual Vermont State Crash Rate for streets of similar roadway conditions (number of lanes, posted speed, and/or functional classification)
  - » In the last 5-years exceed:
    - 10 or more Type 1 crashes (property damage only) or,
    - Two (2) Type 2 crashes (injury) or,
    - One (1) Type 3 crashes (fatality)
  - » In the last year exceed:
    - One (1) Type 2 crashes (injury) involving pedestrian or bicycle or,
    - One (1) Type 3 crashes (fatality) involving pedestrian or bicycle
- **Heavy Trucks:** The reported 24-hour traffic volume classification count must:
  - » Exceed 4% for heavy truck (three or more axles), or
  - » Engineering judgment considering surrounding land use context

BURLINGTON STREET TYPES AND STREET NETWORK

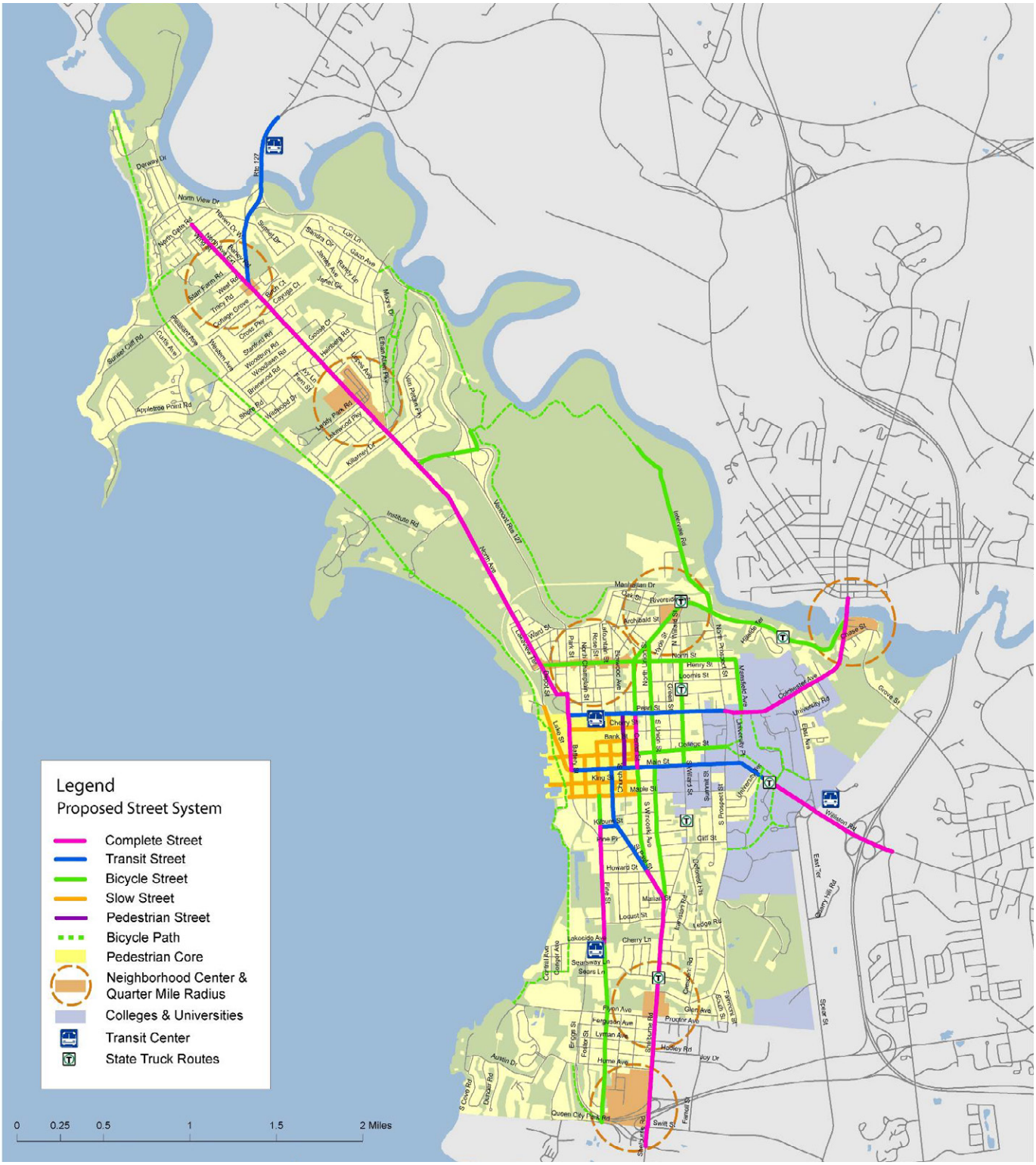


Figure 12. Burlington Street Types and Street Network, 2011 City of Burlington Transportation Plan

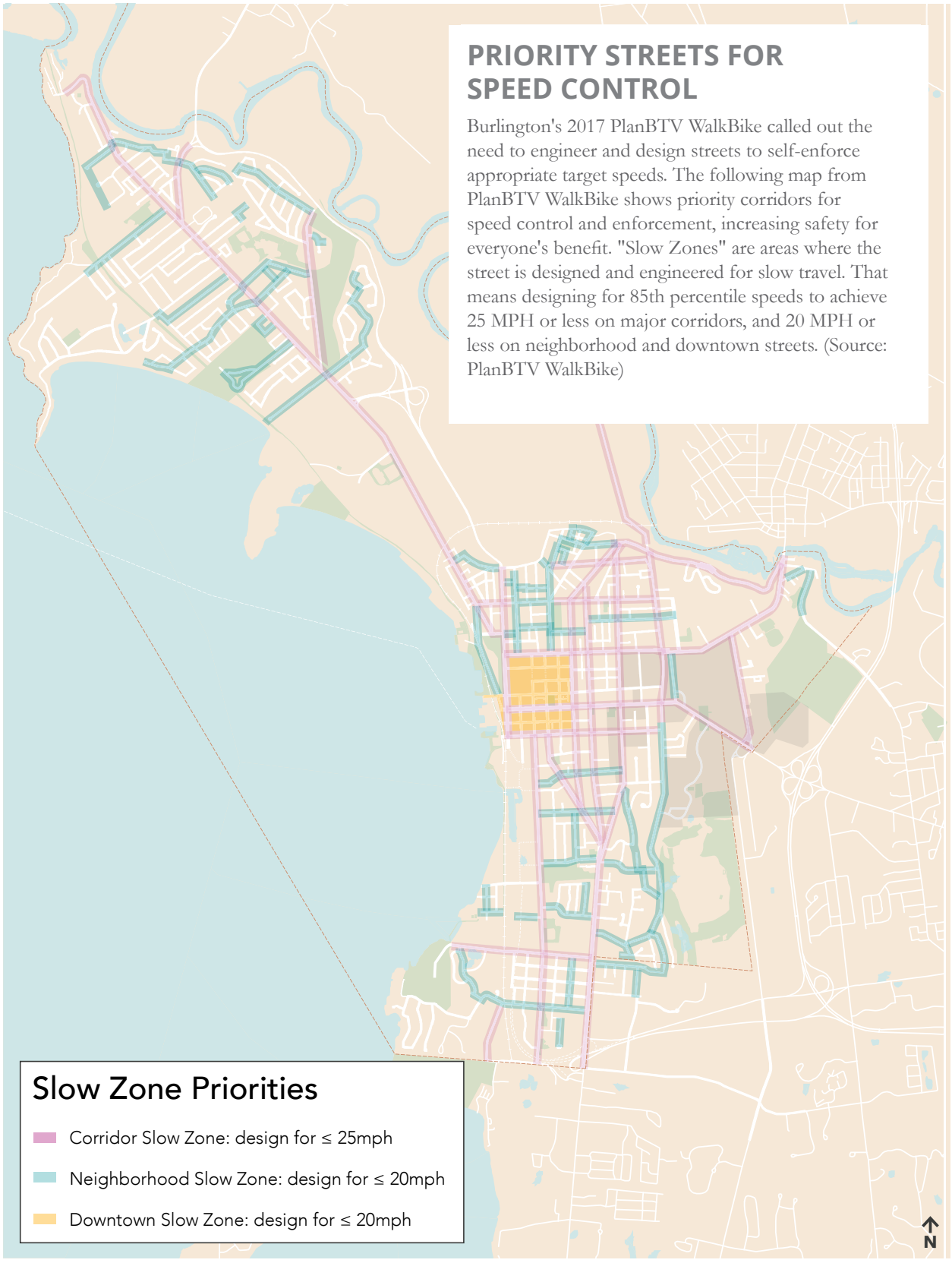


Figure 13. Priority Streets for Speed Control (Source: PlanBTV WalkBike)

STREET TYPOLOGIES

This section describes the five street typologies included in the **City of Burlington Transportation Plan**, Adopted March 2011 and **PlanBTV WalkBike** adopted in 2017.

Neighborhood Street

This category makes up the majority of Burlington's streets. They vary widely in their character and volumes, but predominately are located in residential contexts. It is critical to provide a high quality pedestrian experience and accomplish traffic calming through design on these streets.

Includes: Isham Street, Cedar Street

Figure 14. Isham Street - Neighborhood Street

Slow Street (Slow Zones)

Slow Streets (or Slow Zones) are located within the pedestrian-oriented downtown core of Burlington, and are intended to promote safety and slow travel speeds. PlanBTV described "Slow Zones" as areas where the street is designed and engineered to self-enforce slow travel. That means designing for 85th percentile speeds to achieve 25 MPH or less on major corridors, and 20 MPH or less on neighborhood and downtown streets. PlanBTV includes three Slow Zone Prioroities: Corridor, Neighborhood and Downtown. In these areas, all modes of transportation are in high demand, but pedestrian convenience and safety is prioritized. Slow Streets are designed accommodate the highest density of use and the greatest concentration of pedestrians.

Includes: College Street, Pine Street (from Maple to Pearl)

Traffic Calming Elements of the Slow Street

- High-Visibility Crosswalks
- Medians and Pedestrian Refuge Islands with countdown signals at intersections
- Curbs: Extensions at intersections and high-visibility crosswalks, wider radii for buses
- Vehicle Lanes: Typical width 10 to 11 feet, maximum width 12 feet

Figure 15. College Street - Slow Street

Complete Streets help create livable communities for various types of users, including children, people with disabilities, and older adults. Complete Streets improve equity, safety, and public health, while reducing transportation costs and traffic woes.

- Smart Growth America

Figure 16. Flynn Avenue - Bicycle Street

Bicycle Street

Bicycle Streets, like Transit Streets, have the purposes of giving one mode of transportation priority over other modes. The 2017 PlanBTV WalkBike provided an updated network of Bicycle Streets from those provided in the 2011 Transportation Plan. The Bicycle Street functions to give bicycles priority treatment through improved signage and physical improvements to promote convenience and safety. Along with Slow Streets, Complete Streets, and shared-use paths, Bicycle Streets form a citywide network that will promote greater usage of bicycles as a mode of transportation.

Includes: North Street, Union Street, College Street, Intervale Road

Traffic Calming Elements of the Bicycle Street

- Crosswalks
- On-Street Parking: Parallel or Angled
- Bicycle Lanes: Preferable width 5 to 6 feet, minimum width 4 feet outside of gutter
- Vehicle Lanes: Typical width 10 to 11 feet, minimum width 10 feet

Figure 17. Pearl Street - Transit Street

Transit Street

Transit Streets, like Complete Streets, facilitate travel to and through Burlington's core and are main thoroughfares for the city. Transit Streets, however, differ from Complete Streets in that their purpose is to give transit a "leg up" on other modes of transportation by promoting efficient transit movement on these designated streets. Transit Streets transition from Complete Streets where bicycles are diverted to a parallel Bicycle Street or other path. These streets can promote significant economic development, especially within ¼-mile of a transit stop. Higher volumes of pedestrian traffic may be expected on Transit Streets.

Includes: Main Street, St. Paul Street (from Main to Howard), Pearl Street

Traffic Calming Elements of the Transit Street

- Corner Turning Radius: Minimum 60 foot radius
- Vehicle Lanes: Typical width 10 to 11 feet, maximum width 12 feet

Figure 18. Park Street (Source: Google Street View)

Complete Streets

Complete Streets are the main thoroughfares providing access into and through Burlington. These roadways typically have more travel lanes, wider rights-of-way, and higher traffic volumes and speeds. The goal of the Complete Street is to accommodate all modes as effectively as possible within the right-of-way.

Includes: North Avenue, Colchester Avenue

Traffic Calming Elements of the Complete Street

- High-Visibility Crosswalks
- Medians & Pedestrian Refuge Islands
- Curb extensions and wider radii for buses
- On-Street Parking (if possible)
- Buffered/Conventional Bike Lane: Preferable width 5 to 6 feet, minimum width 4 feet outside of gutter
- Vehicle Lanes: Typical width 10 to 11 feet, maximum width 12 feet

03 TRAFFIC CALMING METHODS & TREATMENTS

Once DPW staff have determined that installation of traffic calming measures is warranted, the next step that they will take will be to evaluate the various traffic calming methods and treatments appropriate for the street typology. This section describes which traffic calming methods/treatments are appropriate for the various street typologies, and includes cut sheets for each method/treatment to assist DPW staff in deciding which methods/treatments to install.

Not all traffic calming treatments are appropriate for all street typologies, and engineering judgment should be incorporated into the consideration of potential context-sensitive design.

+	Most desirable
!	Engineering judgment
-	Not recommended

TRAFFIC CALMING MEASURES AND CONTEXTUAL GUIDANCE

Street Typology	Neighborhood & Slow Street [1,3]		Bicycle Street [1]		Transit Street [1]			Complete Street [1]		
Low-Impact Physical Design	2-lane	3-lane	2-lane	3-lane	2-lane	3-lane	4-lane	2-lane	3-lane	4-lane
Rumble Strips	-	-	-	-	!	!	+	!	+	+
Reallocation of Pavement Space	-	-	+	+	+	+	!	+	+	-
Curb Extension	+	+	+	+	!	!	!	+	+	+
Choker	+	!	+	!	!	!	-	+	!	-
Chicane	+	!	+	!	!	!	-	!	!	-
Speed Hump	+	+	!	!	-	-	-	!	-	-
High-Impact Physical Design										
Raised Crosswalk	+	+	!	!	-	-	-	!	-	-
Raised Intersection	+	+	!	!	-	-	-	!	-	-
Median Refuge Island (intersection treatment)	+	!	+	!	+	!	!	+	!	!
Median Island (midblock treatment)	+	+	+	+	!	!	!	+	+	!
Neighborhood Traffic Circle	+	-	+	-	+	-	-	!	-	-
Road Closure	+	+	+	+	!	-	-	!	-	-
Other Traffic Calming										
Parking Conversion[2] (or modification of parking space)	!	!	!	!	!	!	+	!	!	+

1 Street Typology represents the priority mode for the specific street. This does not suggest that other modes are not in use.
2 Parking Conversion is context dependent, but may refer to widening of on-street parking to restrict the travel lane or conversion of angled- to parallel-parking.
3 See PlanBTVWalkBike Corridor, Neighborhood and Downtown Slow Zones.

↑Figure 19. Table of Traffic Calming Measures and Contextual Guidance

RUMBLE STRIPS

LOW-IMPACT PHYSICAL DESIGN

Description

Rumble strips are patterned sections of rough pavement or topical applications of raised material, perpendicular to the direction of travel, that cause vibration and noise when driven over by the operator of a motor vehicle. This noise and vibration is intended to direct the motorist's attention back to the roadway. FHWA-approved treatments include white- and black-painted stripes. Avoid conflicts with driveways. Typical spacing is 50 - 100 feet apart.

Typical Conditions

Speed: Generally appropriate for roadways with higher posted speed limits, such as transitions from freeways to lower class roadways.

Traffic & Volume: Generally appropriate for any traffic volumes and do not impair truck access, transit, or primary emergency response routes, not appropriate on bicycle routes.

Cost

Ranges between $0.10 to $0.60 per linear foot dependent on:

- Project length
- Availability and selection of materials
- Roadway surface

BASIC ***Speed Reduction Potential*** *-1 to -2 MPH*

Advantages and Disadvantages

Advantages

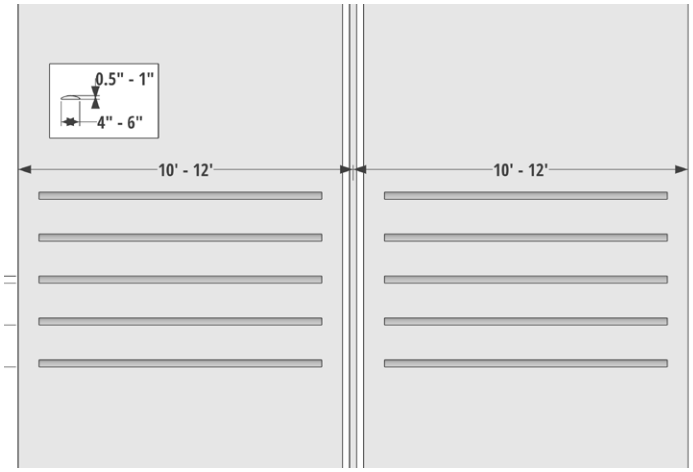
- FHWA studies show 34% reduction in crashes on urban and suburban roads
- Relatively low cost
- Relatively quick installation

Disadvantages

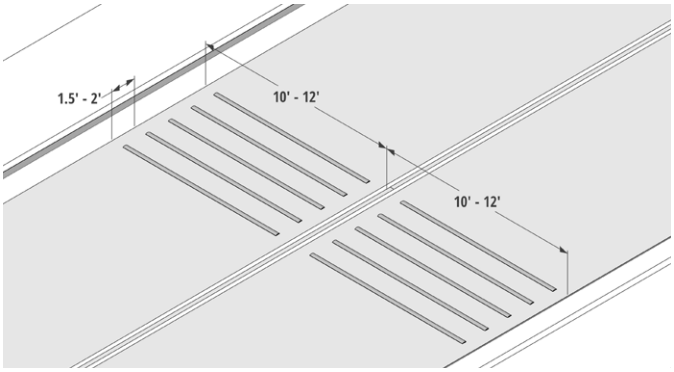
- Not effective on roadways with lower posted speeds
- High noise levels generated by traffic

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example - Source: National Complete Streets Coalition

REALLOCATION OF PAVEMENT SPACE

LOW-IMPACT PHYSICAL DESIGN

Description

Reallocation of pavement space can include removing and/or reconfiguring existing travel lanes or replacing lanes with other facilities such as bicycle lanes, on-street parking or transit uses for example.

Typical Conditions

Speed: Generally appropriate for roadways with lanes in excess of 12 feet wide.

Traffic & Volume: Generally appropriate for all types of urban roadways and have been applied to roadways with daily maximum volumes from 15,000 - 25,000.

Cost

Can be designed internally and implemented with scheduled resurfacing making costs minimal.

BASIC

Speed Reduction Potential

-1 to -2 MPH

Advantages & Disadvantages

Advantages

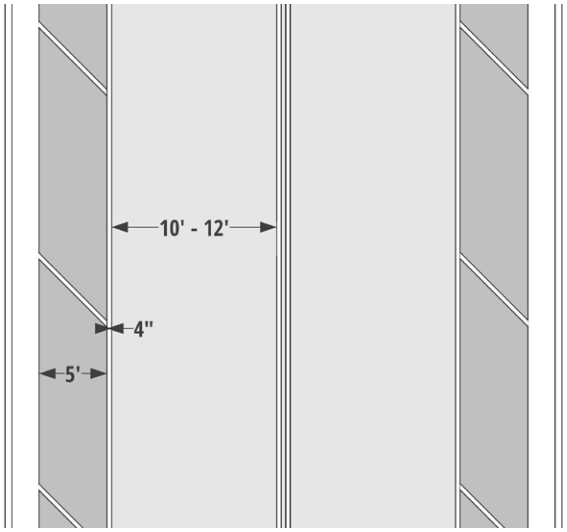
- Lane removal can reduce higher speeds achieved through passing
- Can reduce crashes by 19-47%
- Retains sufficient flow despite lane removal

Disadvantages

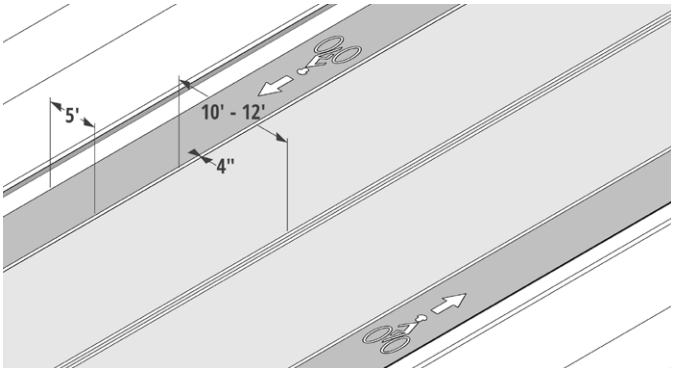
- No significant disadvantages

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail (Roadway striping as lane diet)



Oblique Angle Detail (Conventional bike lanes as lane diet)

Built Example (Buffered bike lanes as a road/lane diet)

CURB EXTENSIONS

LOW-IMPACT PHYSICAL DESIGN

Description

A curb extension (or bulb out) is a horizontal extension of the sidewalk into the street at an intersection effectively narrowing the roadway.

Typical Conditions

Speed: Generally appropriate for all common urban speed limits, provided adequate distance is provided between travel lane and curb.

Traffic & Volume: Generally appropriate for roadways with low to moderate traffic volumes, and are appropriate for all vehicle types, including primary emergency vehicles and transit.

Cost

Ranges between $10,000 and $25,000, dependent upon:

- Drainage considerations
- Utilities relocation
- Size of the extension

FAIR *Speed Reduction Potential*

-3 to -4 MPH

Advantages & Disadvantages

Advantages

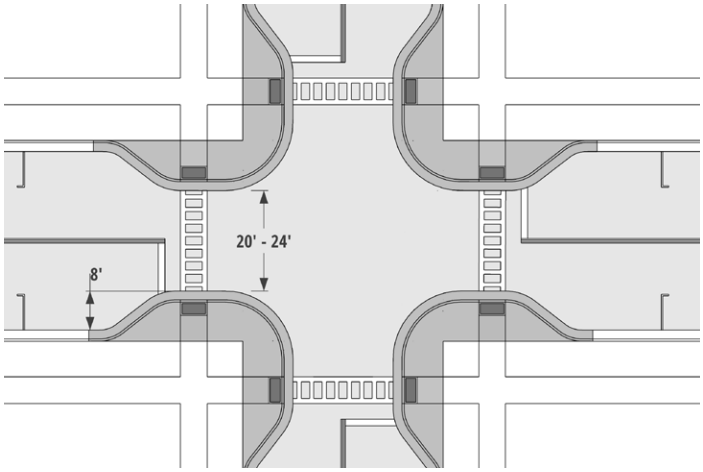
- Slows automobile turning speeds and increases sight triangles for motorists, increasing pedestrian visibility
- Shortens pedestrian crossing distance and improves pedestrian visibility
- Provides protected parking bays
- Creates opportunities for landscaping and amenities at extensions, enhancing beautification

Disadvantages

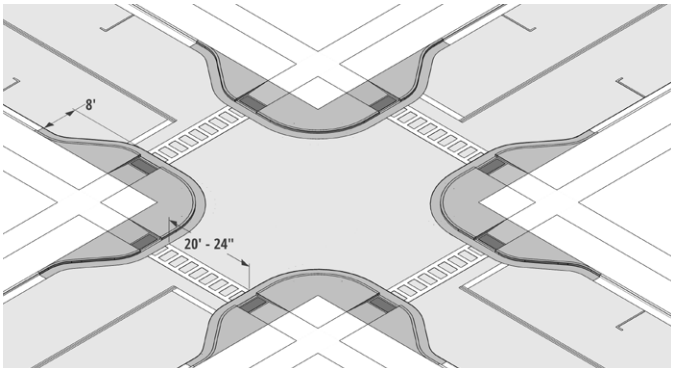
- May require relocation of above- and below-ground utilities, drainage features
- May require some parking removal adjacent to intersections
- Potential for higher costs due to drainage considerations
- Potential to cause vehicle damage to drivers with larger class vehicles who are lost

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example

CHOKER

LOW-IMPACT PHYSICAL DESIGN

Description

A choker is the narrowing of a roadway through the use of curb extensions or roadside islands. It can be created by a pair of curb extensions at a midblock location that narrows the street by widening the sidewalk or planting strip at that location. A choker can also be created through the use of roadside islands or through a curb extension with parking on the opposite side.

Typical Conditions

Speed: Generally appropriate for all common urban speed limits, provided adequate distance is provided between travel lane and curb.

Traffic & Volume: Generally appropriate for roadways with low to moderate traffic volumes, and are appropriate for all vehicle types, including primary emergency vehicles and transit.

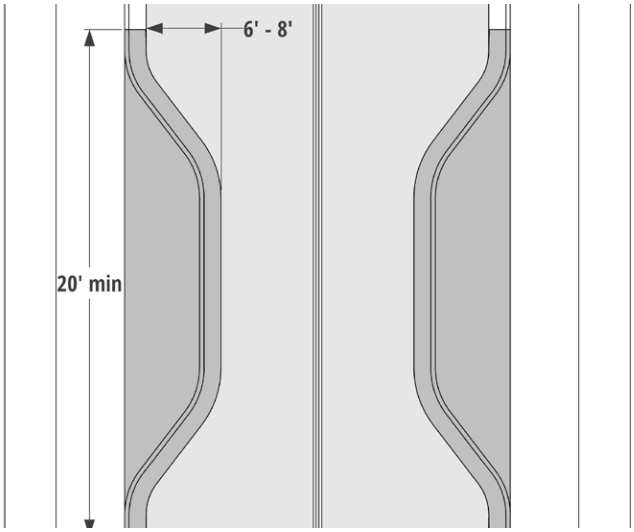
Cost

Between $10,000 and $25,000 per extension, dependent upon:

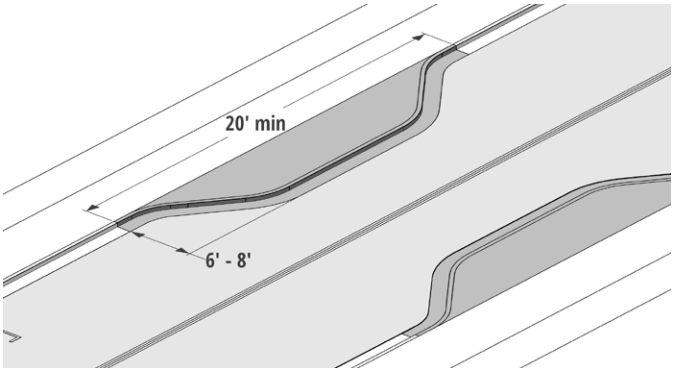
- Drainage considerations
- Utilities relocation
- Size of the extension

FAIR — *Speed Reduction Potential*

-3 to -4 MPH



Plan View Detail



Oblique Angle Detail

Built Example

Advantages and Disadvantages

Advantages

- Opportunities for landscaping and amenities can significantly increase neighborhood and streetscape beautification
- Provides opportunity for a mid-block crosswalk
- Provides protection for on-street parking
- Applicable with or without dedicated bicycle facilities

Disadvantages

- May require relocation of drainage features and utilities
- May require some parking removal
- Potential for higher costs due to drainage considerations

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures

CHICANE

C T B P LOW-IMPACT PHYSICAL DESIGN

Description

A chicane is a series of alternating curves or lane shifts that are located in a position to force a motorist to steer back and forth out of a straight travel path. The chicane curves can be created with a curb extension that alternates from one side of the street to the other. A chicane-like effect can also be achieved by alternating on-street parking from one side of the street to the other.

Typical Conditions

Speed: Generally appropriate for roads with posted speed limits of up to 35 miles per hour.

Traffic & Volume: Generally appropriate for roads with low traffic volumes and for all vehicle types, including emergency response vehicles and transit routes.

Cost

Range from $5,000 to $10,000 per chicane dependent upon:

- Materials used (temporary or permanent)
- Drainage considerations
- Utilities relocation
- Size/length of the chicane

GOOD ***Speed Reduction Potential***
-6 to -9 MPH

Advantages and Disadvantages

Advantages

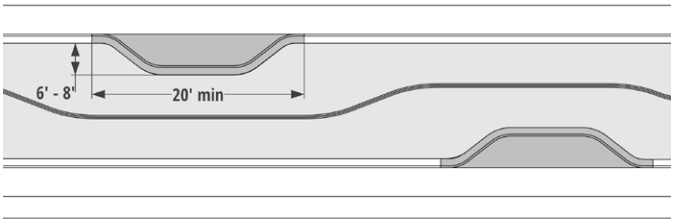
- Appropriate in both urban and suburban settings
- Landscaping the areas of deflection can create green space
- Slows traffic by encouraging motorists to moderate vehicle speed through the horizontal deflection

Disadvantages

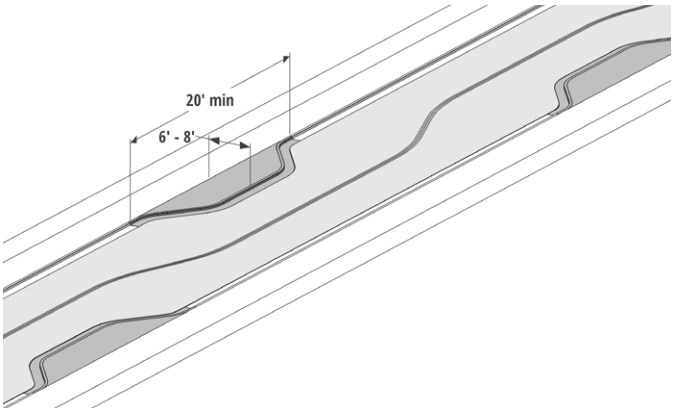
- Bicyclists and motor vehicles share the lane
- Drivers may cut straight paths across center line (striping, without median)

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail


Built Example - Source: Dan Burden, Walkable Communities

SPEED HUMP

LOW-IMPACT PHYSICAL DESIGN

Description

A speed hump is an elongated mound in the roadway surface extending across the travel way at a right angle to the traffic flow. It uses vertical deflection to create motorist discomfort and thereby reduces speed. Burlington DPW offers two sizes of speed humps, 14 feet or 22 feet wide, the larger size being more appropriate for higher volume streets. Typical placement is midblock and spaced 300 - 500 feet apart. Avoid conflicts with driveways.

Typical Conditions

Speed: Generally not appropriate for roadways with a posted speed of 45 miles per hour or above.

Traffic & Volume: Not appropriate for truck access routes, transit routes, or primary emergency response routes; Appropriate for roads with grades below eight percent.

Variation: Speed Cushions can be used as a variation along primary emergency routes or transit routes.

Cost

Between $2,000 - $4,000 dependent on drainage design

GOOD ***Speed Reduction Potential***
-6 to -8 MPH

Advantages and Disadvantages

Advantages

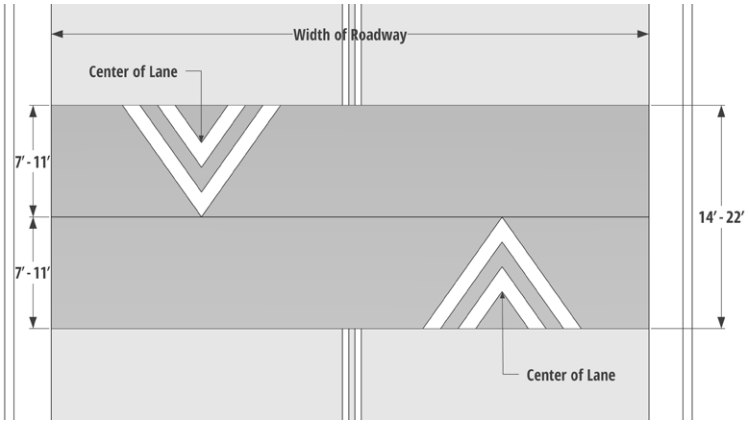
- Bicyclist safety is relatively unaffected
- Typical traffic volume reductions of 20% (series of humps)
- Crash rate reductions of approximately 40% are typical

Disadvantages

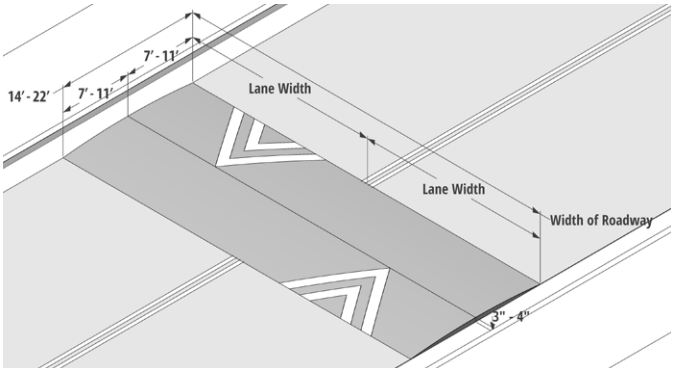
- When applied as a single treatment, little to no traffic volume reduction or diversion should be expected
- Increased noise levels from vehicles impacting the hump
- Not appropriate for primary emergency vehicle routes or streets providing access to a hospital or emergency medical services
- Not appropriate for transit routes or primary access routes for industrial or commercial sites
- Adequate stopping sight distance or warning signs provided
- Snow plow damage to speed hump

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example

RAISED CROSSWALK

HIGH-IMPACT PHYSICAL DESIGN

Description

A raised crosswalk is a raised area extending perpendicular to the roadway, accompanied by a pedestrian crosswalk on the raised surface, designed to physically limit the speed at which a vehicle can traverse it. Raised crosswalks may be installed at both midblock and intersections and ranges in height based on the roadway type. Refer to Burlington Crosswalk Guidelines. Crosswalks should not be installed solely for the purpose of traffic calming, they must also meet the warrants for a marked crosswalk or an enhanced crosswalk.

Typical Conditions

Speed: Generally appropriate for roadways with posted speed limits up to 35 miles per hour.

Traffic & Volume: Not appropriate for primary emergency vehicle response routes, or roadways providing access to medical facilities.

Cost

Ranges between $2,500 to $8,000 for asphalt table. Higher costs may be incurred for brickwork, stamped asphalt, concrete ramps, and other pedestrian crossing enhancements.

GOOD ***Speed Reduction Potential***
-6 to -9 MPH

Advantages and Disadvantages

Advantages

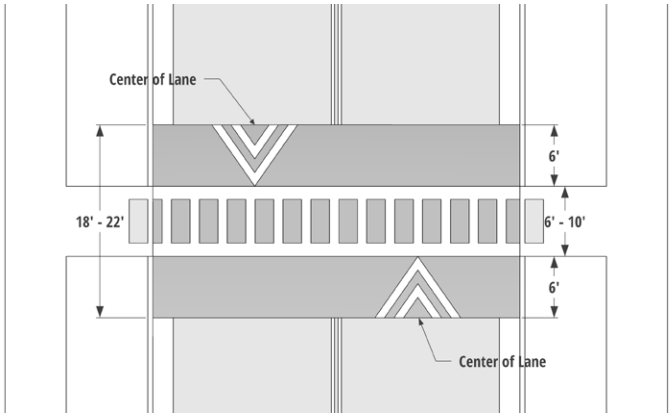
- Increased pedestrian connectivity creates a more walkable community
- Reduces speeds to between 25 to 35mph at the crosswalk
- Bicycle safety relatively unaffected
- When used in a series, traffic volume reductions of up to 20% observed

Disadvantages

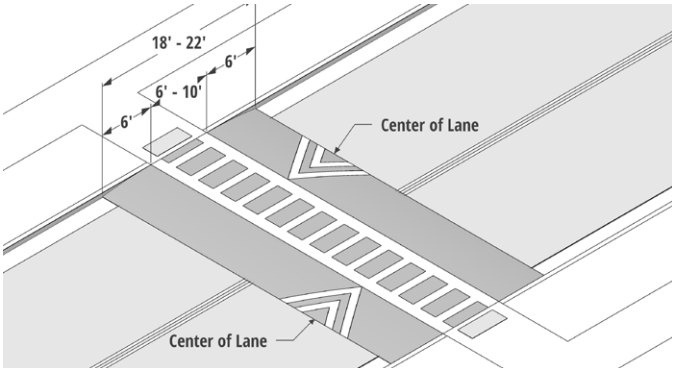
- Should not be located within 50-75 feet of bus stops
- Not appropriate for primary emergency vehicle routes or streets providing access to a hospital or medical services
- Snow plow damage to raised crosswalk
- Potential increase in noise and in traffic on adjacent streets

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- Burlington's Crosswalk Guidelines
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example - Source: Dan Burden, Walkable Communities

RAISED INTERSECTION

HIGH-IMPACT PHYSICAL DESIGN

Description

A raised intersection is a flat, raised area covering an entire intersection, including the crosswalks, with ramps on all approaches. A raised intersection typically rises no more than 3 inches. They often have brick or other decorative materials or textures applied.

Typical Conditions

Speed: Generally appropriate for posted speed limits of up to 30 miles per hour.

Traffic & Volume: Generally appropriate in lower volume conditions and are suitable for transit and emergency response vehicle routes.

Cost

Ranges between $25,000 to $70,000 dependent upon several factors, including road size, drainage conditions, materials, and pedestrian enhancements.

BASIC *Speed Reduction Potential*

-1 to -2 MPH

Advantages and Disadvantages

Advantages

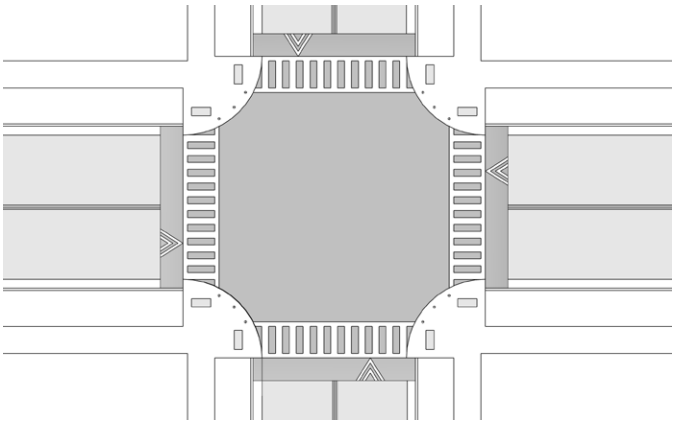
- Versatile in both residential and commercial settings, and can enhance intersection aesthetics
- Large trucks are slowed and/or delayed between two to six seconds crossing the intersection
- Works well with curb extensions and textured crosswalks
- Improves accessibility
- Detectable warnings and/or color contrasts must be incorporated to differentiate the roadway and the sidewalk

Disadvantages

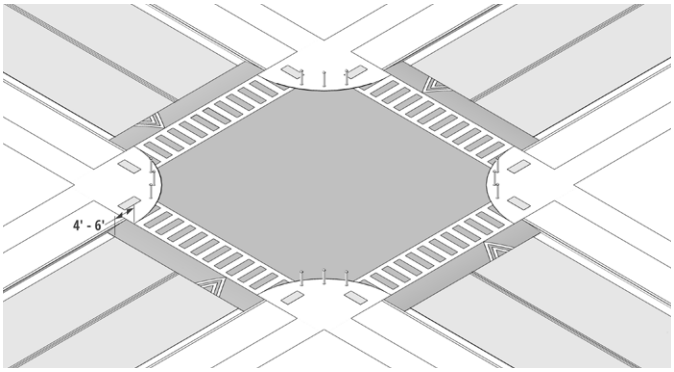
- Reduction in mid-block speeds typically less than 10 percent
- May require bollards to define edge of roadway
- Storm drainage/underground utility modifications are likely necessary
- Potential for higher costs depending upon width of intersecting roads and drainage considerations
- Maintenance of materials used (brick, striping)

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example

MEDIAN ISLAND (INTERSECTION)

HIGH-IMPACT PHYSICAL DESIGN

Description

A median island (intersection) is also called a median refuge island and is a median located at an intersection along the centerline that narrows the travel lanes. A median island may be a painted area or a raised curb, with or without landscaping. A central cutout can create a pedestrian refuge. At intersections, a median island may also be called a pedestrian or splitter island.

Typical Conditions

Speed: Generally appropriate for roads with posted speed limits of up to 35 miles per hour.

Traffic & Volume: Appropriate for all traffic volumes and vehicle types.

Cost

Ranges between $10,000 to $15,000 are expected for installation of the median island, dependent upon size, material, landscaping and drainage considerations.

FAIR

Speed Reduction Potential

-3 to -6 MPH

Advantages and Disadvantages

Advantages

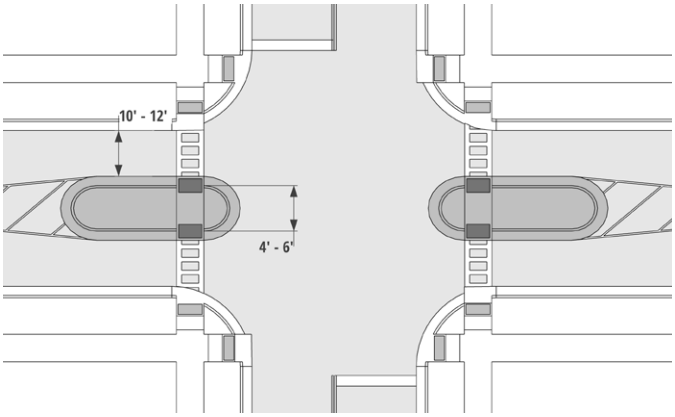
- Reduces pedestrian crossing distance and increases visibility,
- With a variety of materials, medians can greatly enhance neighborhood aesthetics
- Raised curbing increases visibility and nighttime safety
- Reduces vehicle conflict points
- 46 to 56% reduction in pedestrian crashes observed

Disadvantages

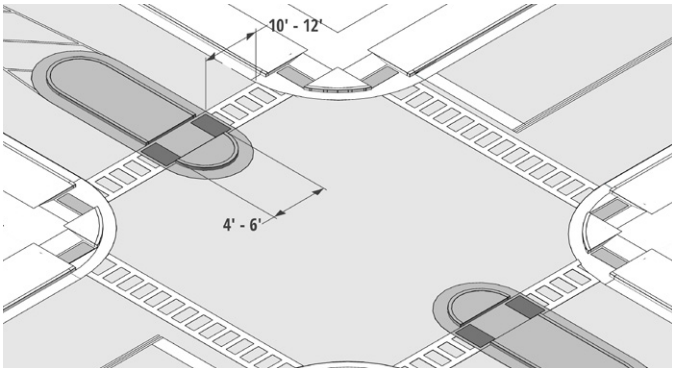
- Landscaping maintenance costs can increase depending on vegetation used
- Potential for higher costs depending upon drainage and utilities considerations
- Turning radius may be impacted for larger vehicles

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example

MEDIAN ISLAND (MIDBLOCK)

HIGH-IMPACT PHYSICAL DESIGN

Description

A median island (midblock) is a raised island located along the street centerline that narrows the travel lanes. Unlike the median refuge island, the median island is located at midblock locations. A median island may be a painted area or a raised curb (preferred), with or without landscaping, to further reduce the open feel of a street.

Typical Conditions

Speed: Generally appropriate for roads with posted speed limits of up to 35 miles per hour.

Traffic & Volume: Appropriate for all traffic volumes and vehicle types.

Cost

Ranges between $10,000 to $15,000 are expected for installation of the median island, dependent upon size, material, landscaping and drainage considerations.

FAIR — *Speed Reduction Potential* *-3 to -6 MPH*

Advantages and Disadvantages

Advantages

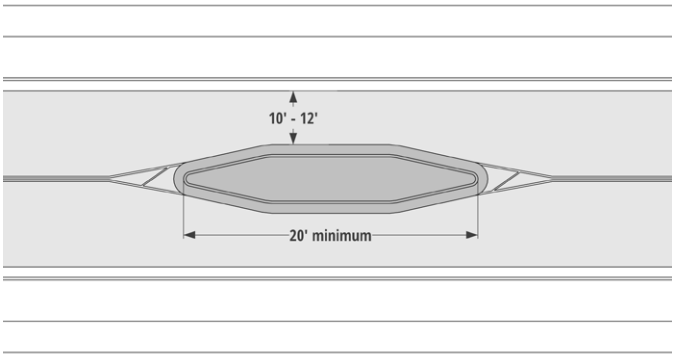
- Can function as a midblock pedestrian refuge island
- With a variety of materials, medians can greatly enhance neighborhood aesthetics
- Light crowning increases visibility and nighttime safety
- Reduces vehicle conflict points

Disadvantages

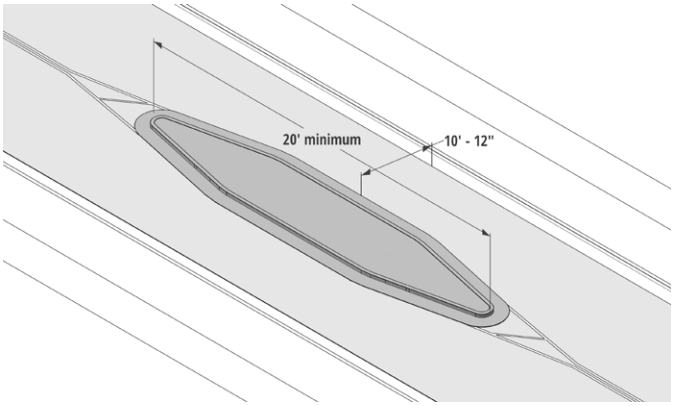
- Bicyclist and motor vehicles share the lane
- Landscaping maintenance costs
- Potential for higher costs depending upon drainage and utilities considerations
- Can restrict driveway access where driveways are located within the limits of the island
- Damage to snow plows, damage from snow plows

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example

NEIGHBORHOOD TRAFFIC CIRCLE

HIGH-IMPACT PHYSICAL DESIGN

Description

A traffic circle is a raised island, placed within an unsignalized intersection, around which traffic circulates. The circle may have Stop signs or Yield signs on the intersection approaches. The island forces a motorist to use reduced speed when entering and passing through an intersection. Though similar to a roundabout, traffic circles do not follow modern design roundabout principles, as there is no horizontal deflection on the approach.

Typical Conditions

Speed: Generally appropriate only for streets with low posted speed limits of up to 30 miles per hour.

Traffic & Volume: Generally appropriate for streets with less than 2,000 vehicles per day, and are not appropriate for trucks with more than two axles, emergency vehicles, or transit routes.

Cost

Ranges between $10,000 to $25,000, dependent upon drainage considerations, utilities, landscaping, and circle diameter.

FAIR — *Speed Reduction Potential*

-4 MPH

Advantages and Disadvantages

Advantages

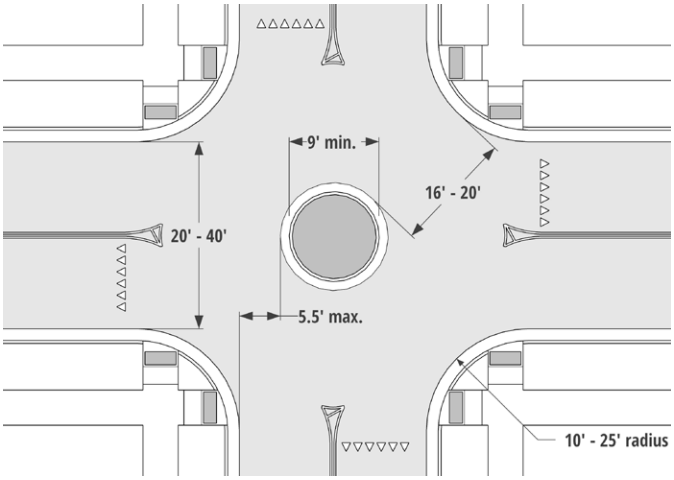
- Observed speed reductions of four miles per hour are typical at the traffic circle; reduced speeds continue beyond the intersection
- Greater speed reductions achieved with installation of splitter islands
- Reduction in number of angle and turning crashes

Disadvantages

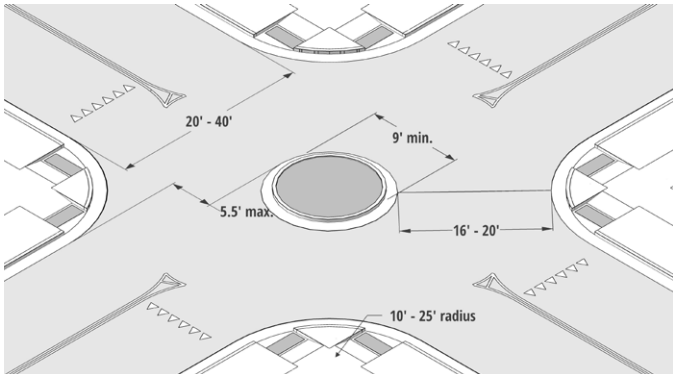
- Not appropriate where transit routes must make left turns
- Emergency vehicles and large trucks typically may turn left in front of the circle in order to navigate the intersection

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example

ROAD CLOSURE (FULL)

HIGH-IMPACT PHYSICAL DESIGN

Description

A full street closure is a physical barrier, whether at an intersection or midblock, that is placed across a street to close the street completely to through vehicle traffic. A full closure can be designed to allow bicyclists and pedestrians to pass through. An operational analysis shall be completed prior considering this treatment.

Typical Conditions

Speed: Generally appropriate for all common urban posted speed limits, with adequate advance warning given to road users.

Traffic & Volume: Generally appropriate for roadways with low traffic volume, and are not appropriate for primary emergency vehicle response, truck, or transit routes.

Cost

Ranges from as little as $1,500 to $10,000 depending upon method of closure chosen. Costs vary substantially dependent on treatment, and include potential considerations for drainage, construction, and restriping.

FAIR — ***Speed Reduction Potential***
N/A - Diverts traffic

Advantages and Disadvantages

Advantages

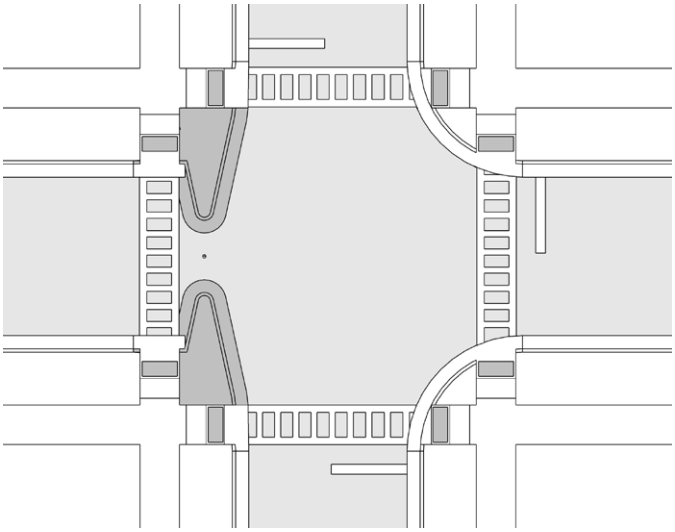
- Highest degree of traffic volume reduction
- Increased pedestrian and bicyclist safety
- Eliminates vehicle conflict points

Disadvantages

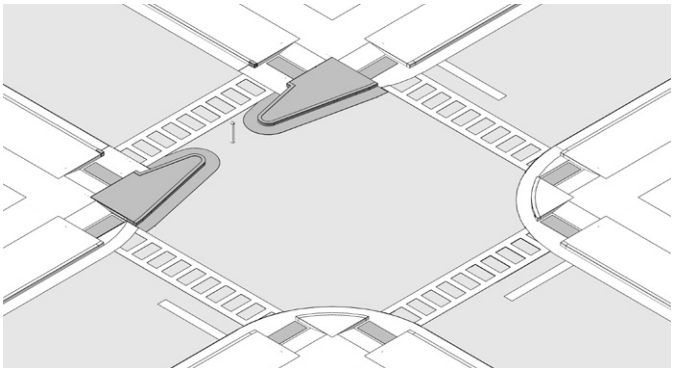
- Without design considerations (e.g., mountable curbs, removable delineators) restricts emergency response vehicles and thereby affects access and response time
- Reduces overall network connectivity
- Adverse effects to property accessibility
- Diverts traffic to other streets and may increase volume elsewhere
- Potential for high costs dependent upon degree of integration with streetscape, drainage considerations

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example

ROAD CLOSURE (PARTIAL)

HIGH-IMPACT PHYSICAL DESIGN

Description

A partial closure is a physical barrier that blocks vehicle travel in one direction for a short distance on an otherwise two-way street. A partial closure can block either traffic entering the side or exiting the side street, depending on its placement. The traffic movement that is obstructed by the half closure is rerouted along an alternative path.

Typical Conditions

Speed: Generally appropriate for all common urban posted speed limits, with adequate advance warning given to road users.

Traffic & Volume: Generally appropriate for roadways with low traffic volume, and are not appropriate for primary emergency vehicle response, truck, or transit routes.

Cost

Costs range from as little as $3,000 to $10,000 depending upon the complexity of the closure. They vary substantially dependent on treatment, and include potential considerations for drainage, construction, and restriping.

GOOD

Speed Reduction Potential

-6 MPH

Advantages and Disadvantages

Advantages

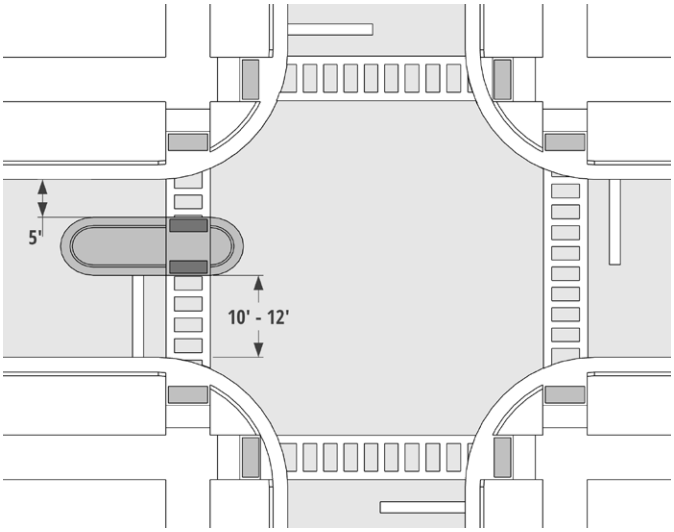
- Speed and volume reductions for the closed travel lane
- Increased pedestrian and bicyclist safety

Disadvantages

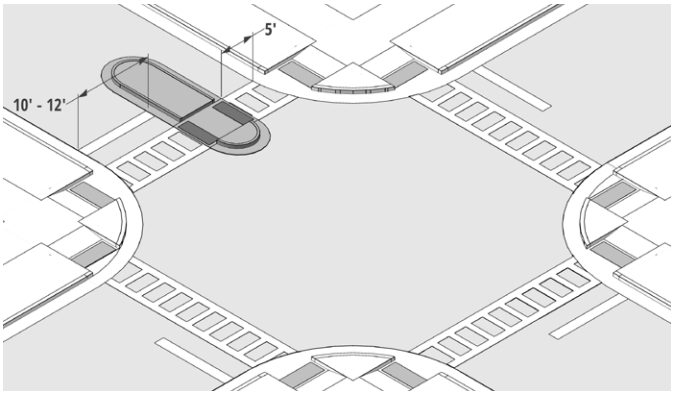
- Not appropriate for emergency vehicle response routes
- Reduces overall network connectivity
- Adverse effects to property accessibility
- Diverts traffic and increases volume elsewhere

References

- Burlington's Intersection Design Vehicle Policy
- Burlington's Engineering Standards
- FHWA Traffic Calming ePrimer
- ITE Traffic Calming Measures



Plan View Detail



Oblique Angle Detail

Built Example

A NOTE ON NEIGHBORHOOD ENHANCEMENTS

Welcome Signage

These signs are not regulatory traffic control signs, such as stop signs, speed limit signs, or yield signs, but are instead unique to the neighborhood context. In addition to signs, planters, or other beautification elements may be implemented and may serve to calm traffic. An application for an Encumbrance Permit through DPW is required to implement these elements.

Examples:

- DPW provides lawn signs at no cost to neighbors
- "Welcome to our Neighborhood" signs can be requested through an Encumbrance Permit (DPW)

Figure 20. Neighborhood signage

New Tree Requests

Through Burlington, Parks, Recreation and Waterfront, new trees may be requested for neighborhood enhancement. Trees placed between the street and sidewalk can serve to beautify the area as well as protect pedestrians along the sidewalk.

Advantages & Disadvantages

- Neighborhood beautification
- Potential traffic calming
- Enhances pedestrian experience

Figure 21. Street trees can beautify the streetscape and protect pedestrians from vehicles traveling the roadway

Street Light Improvements

Through Burlington Electric Department, street light improvements may be requested. Adequate street lighting can improve safety for pedestrians and motorists and is a valuable neighborhood enhancement tool.

Advantages & Disadvantages

- Increased visibility for motorists and pedestrians
- Potential enhancements to street and neighborhood safety

Street Murals

Street murals can be a very creative way to bring art and color to the neighborhood. They provide visual interest and may serve to calm traffic. An application for an Encumbrance Permit through DPW is required to implement these elements.

Figure 22. Street or intersections murals bring color and art to neighborhood streets

04 RESOURCES & CONTACTS

TRAFFIC CALMING RESOURCES

Visit the Department of Public Works (DPW) Traffic Calming and Neighborhood Enhancement Program webpage for more information:

https://www.burlingtonvt.gov/DPW/Traffic-Calming-Neighborhood-Enhancement-Program

Traffic Calming Program

Insert general contact email

Insert general contact phone number

SOURCES, REFERENCES & STANDARDS

This Manual was created with reference to national standards for traffic calming and roadway design engineering, including the following:

- Federal Highways Administration (FHWA) Office of Safety. Traffic Calming ePrimer. Available: https://safety.fhwa.dot.gov/speedmgt/traffic_calm.cfm; Accessed March 2020. Last modified: February 15, 2017.
- Institute of Transportation Engineeers (ITE). Traffic Calming Measures Guide. Available: https://www.ite.org/technical-resources/traffic-calming/traffic-calming-measures/ ; Accessed March 2020. Last Modified:
- Federal Highways Administration (FHWA). Manual on Uniform Trafffic Control Devices (MUTCD). Available: https://mutcd.fhwa.dot.gov/kno_2009r1r2.htm; Accessed March 2020. Last Modified: March 30, 2020.

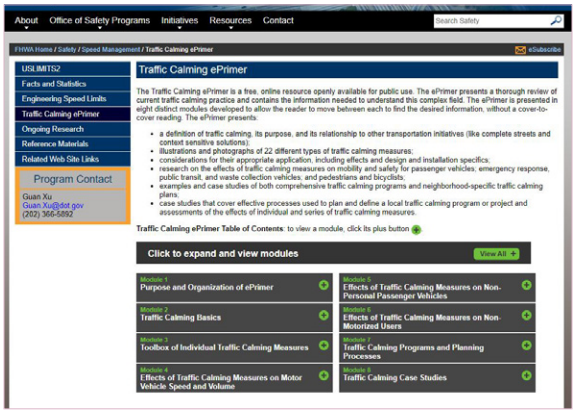


Figure 23. FHWA website for the Manual on Uniform Trafffic Control Devices

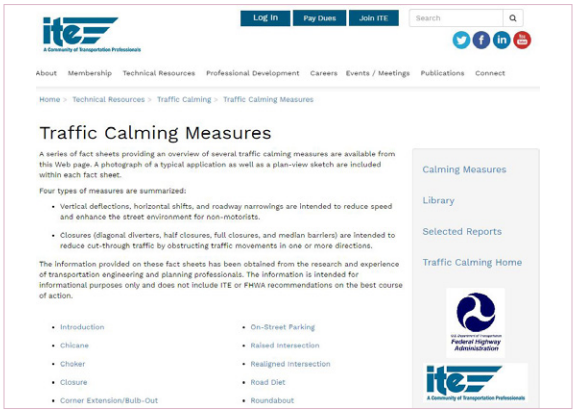


Figure 24. Top: FHWA webpage for the Traffic Calming ePrimer; Above: ITE webpage for the Traffic Calming Measures Guide.

Burlington Public Works Department
645 Pine St Suite A
Burlington, VT 05401
(802) 863-9094